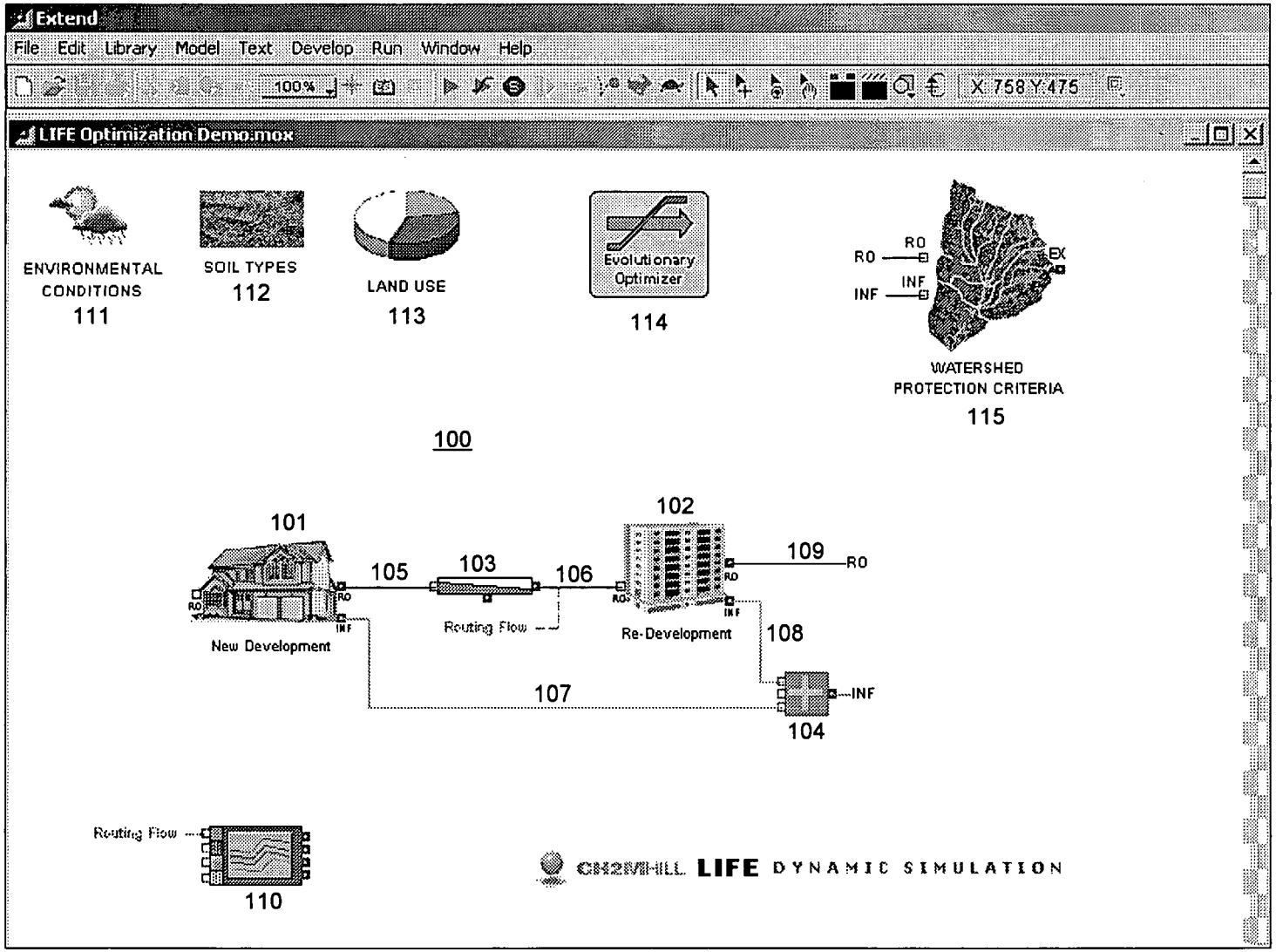


FIG. 1

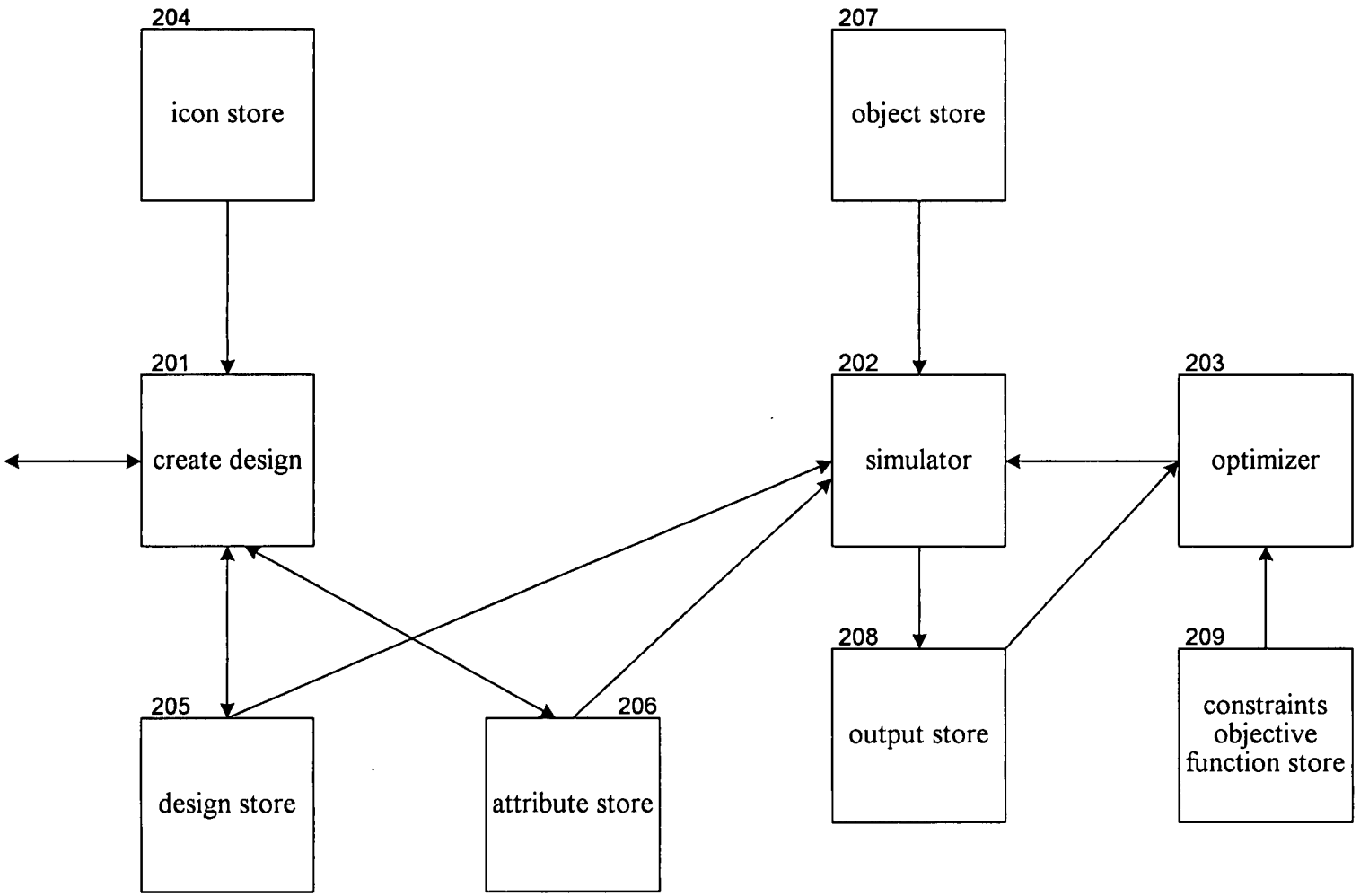

204
icon store
207
object store
201
create design
202
simulator
203
optimizer
208
output store
209
constraints objective function store
205
design store
206
attribute store

FIG. 2

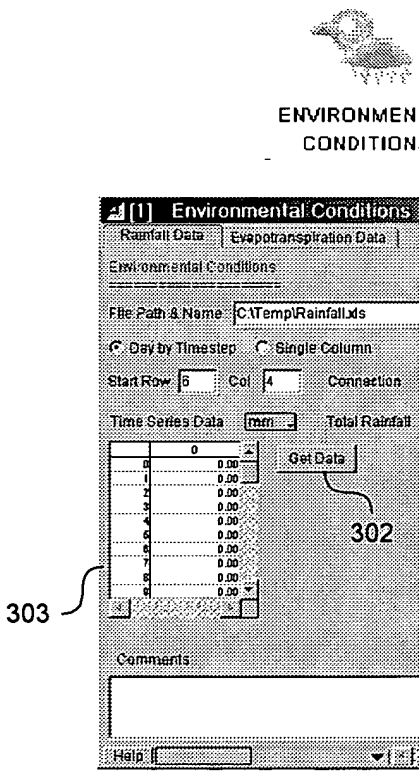
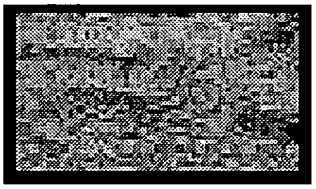
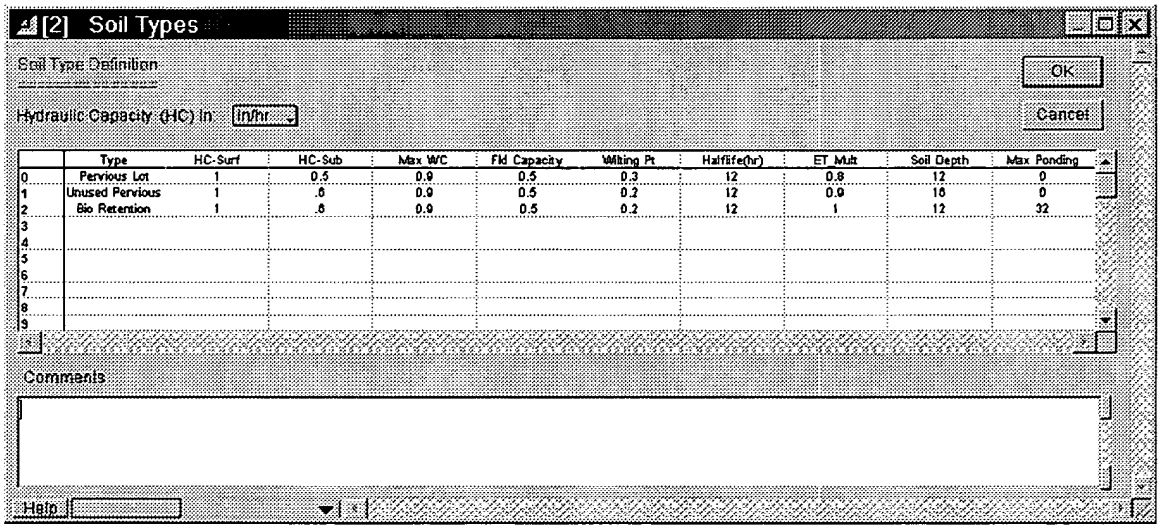

ENVIRONMENTAL CONDITIONS
300
[1] Environmental Conditions
Rainfall Data
Evapotranspiration Data
Environmental Conditions
OK
Cancel
File Path & Name
C:\Temp\Rainfall.xls
Day by Timestep
Single Column
Start Row
Col
Connection
Time Series Data
mm
Total Rainfall
Get Data
302
304
301
303
Comments
Help
[1] Environmental Conditions
Rainfall Data
Evapotranspiration Data
Environmental Conditions
OK
Cancel
Elevation
550
ft
Julian Day
Latitude
41
Temperature
oF
Coastal
Humid
Max
105
Min
30
Time Series Data
mm
Calculate
312
311
313
Comments
Help

FIG. 3



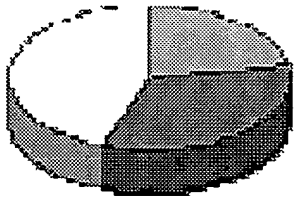
400

SOIL TYPES



401

FIG. 4



500

LAND USE

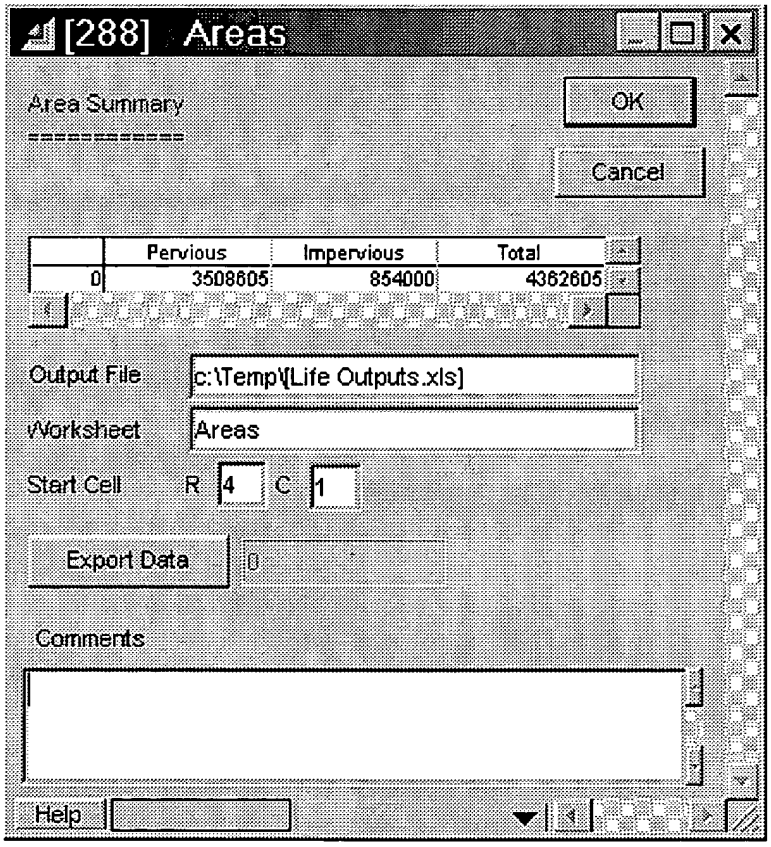


FIG. 5

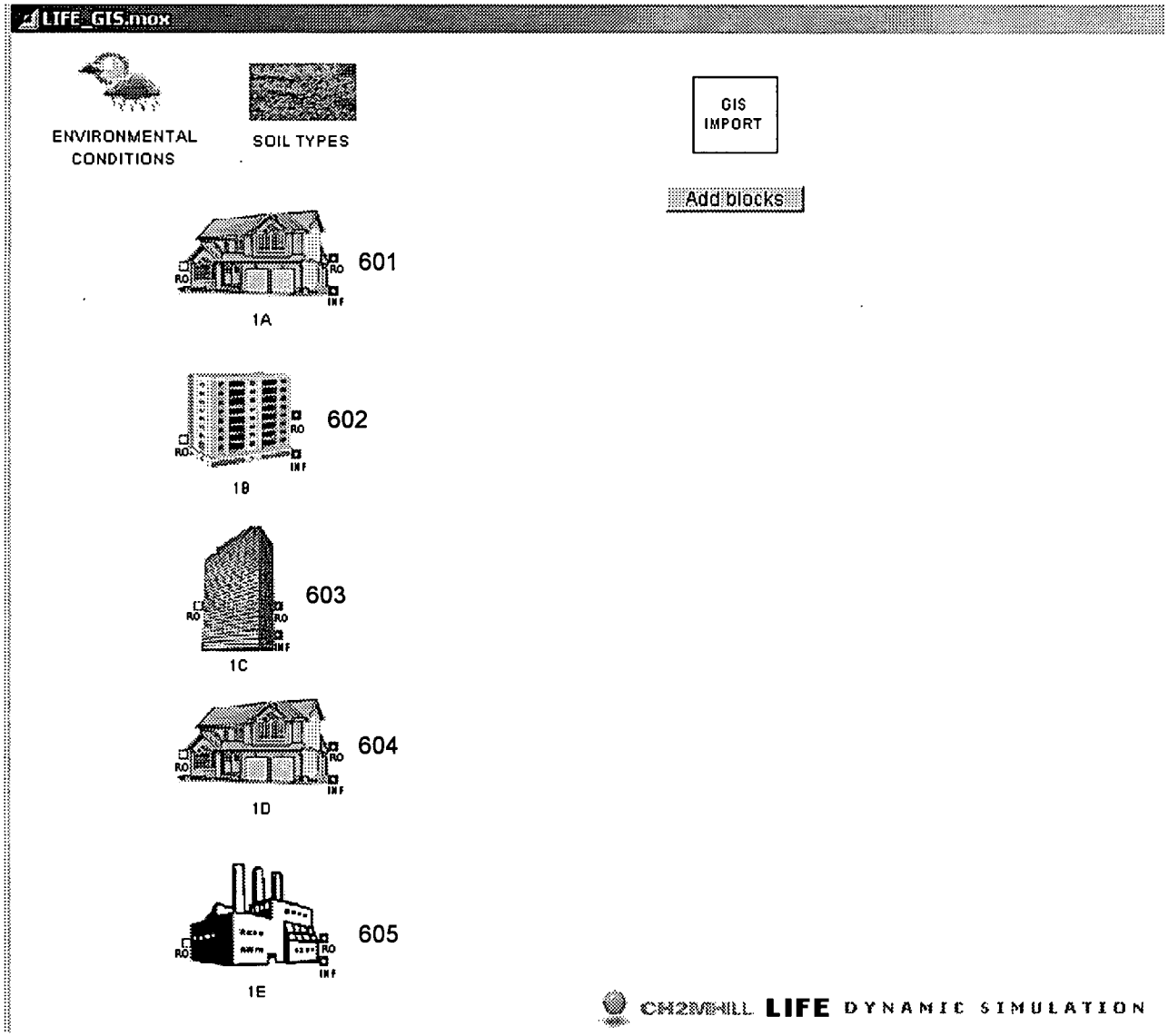

LIFE_GIS.mox
ENVIRONMENTAL CONDITIONS
SOIL TYPES
GIS IMPORT
Add blocks
601
1A
602
1B
603
1C
604
1D
605
1E
CH2MHILL LIFE DYNAMIC SIMULATION

FIG. 6

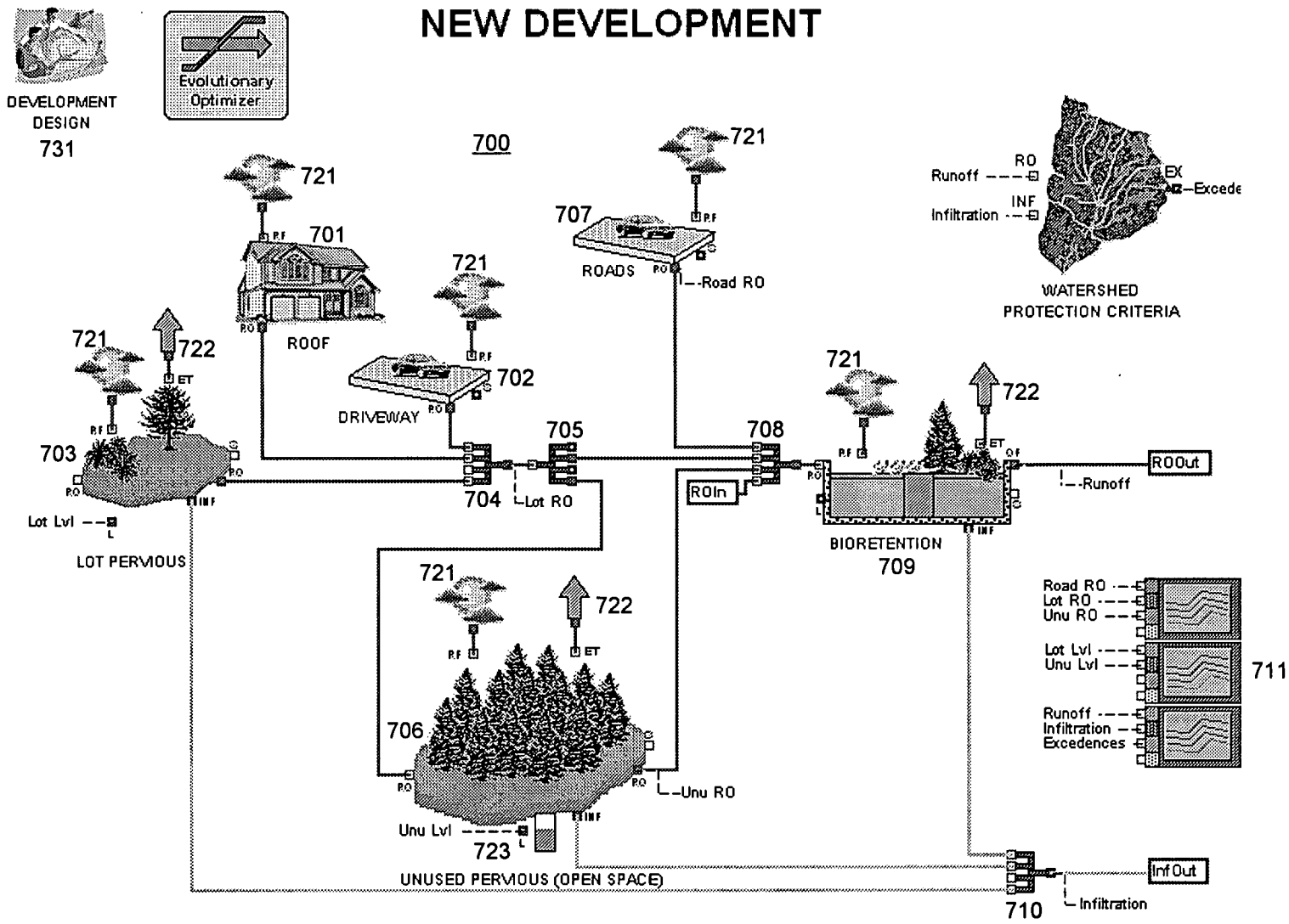
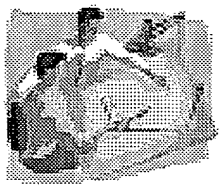
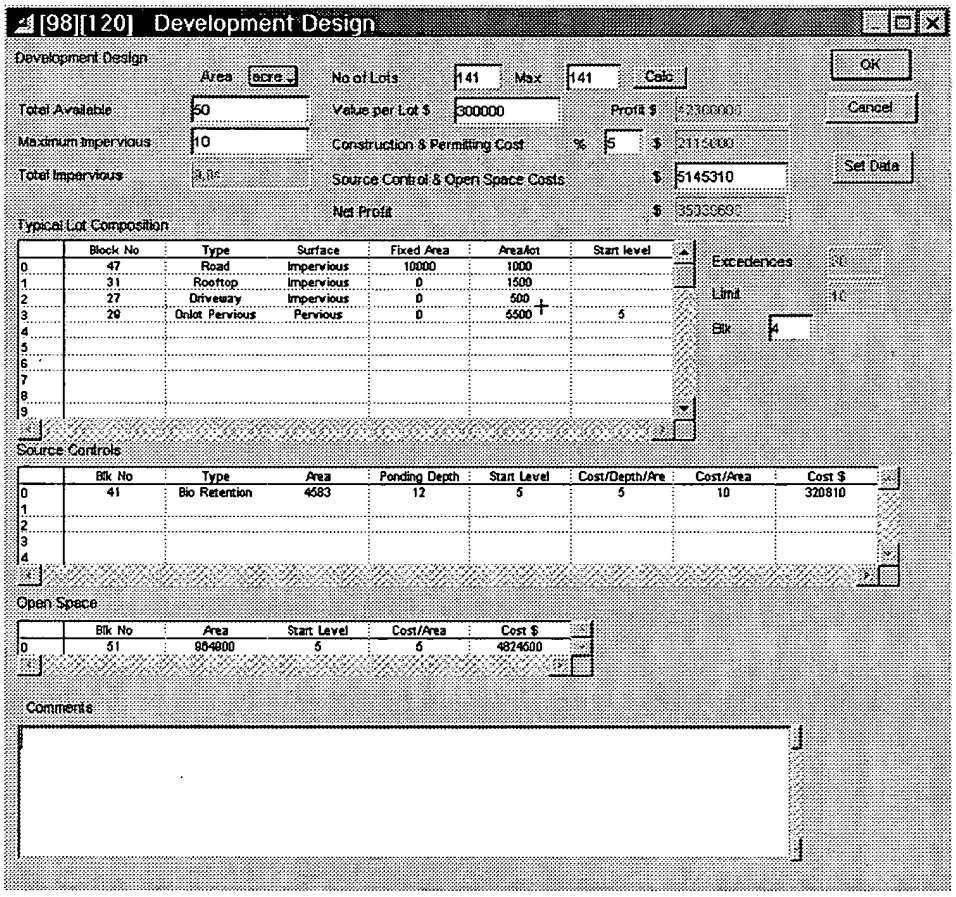

NEW DEVELOPMENT
DEVELOPMENT DESIGN
731
Evolutionary Optimizer
700
721
701
ROOF
721
702
DRIVEWAY
721
707
ROADS
Road RO
721
722
703
Lot Lvl
LOT PERVIOUS
704
Lot RO
705
708
ROIn
721
722
BIORETENTION
709
ROOut
Runoff
RO
Runoff
INF
Infiltration
EX
Excede
WATERSHED PROTECTION CRITERIA
721
722
706
Unu RO
Unu Lvl
723
UNUSED PERVIOUS (OPEN SPACE)
Road RO
Lot RO
Unu RO
Lot Lvl
Unu Lvl
Runoff
Infiltration
Excedences
711
710
Inf Out
Infiltration

FIG. 7



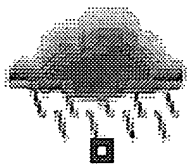
800

DEVELOPMENT
DESIGN

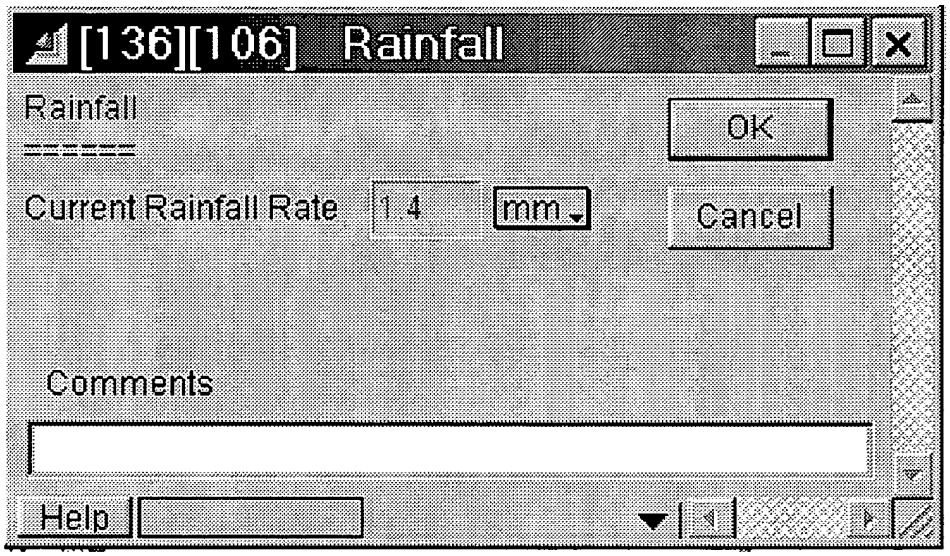


801

FIG. 8



900


[136][106] Rainfall
Rainfall
OK
Current Rainfall Rate
1.4
mm
Cancel
Comments
Help

901

FIG. 9

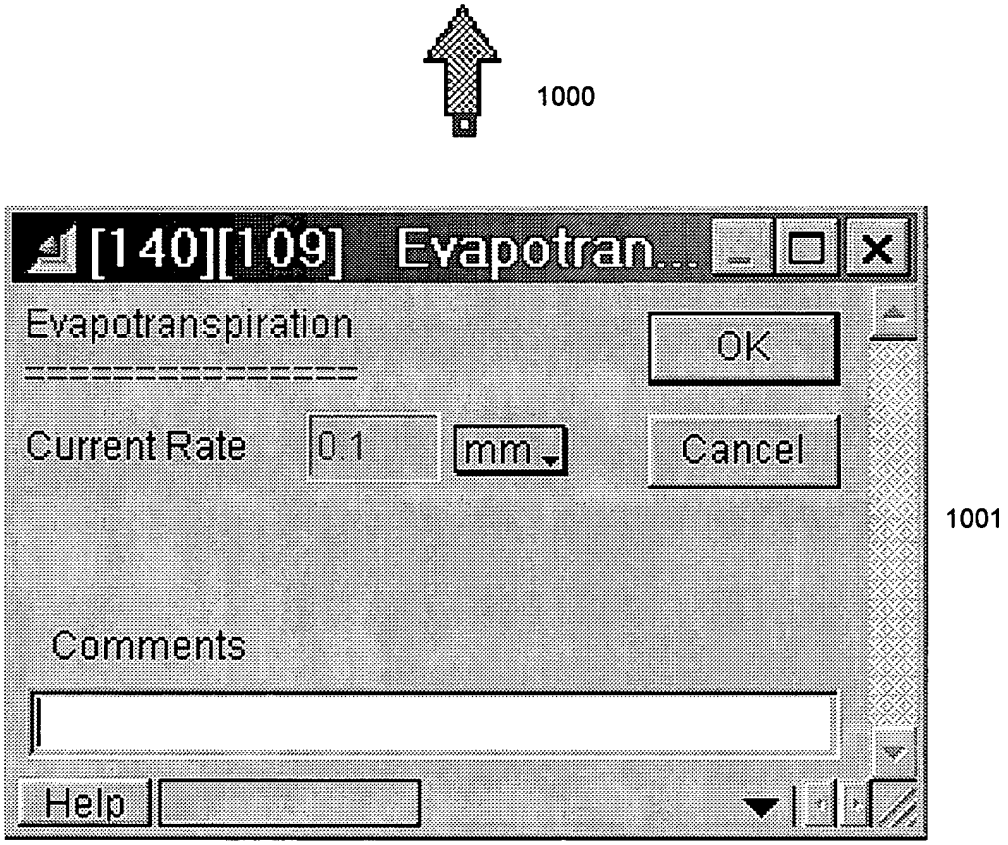
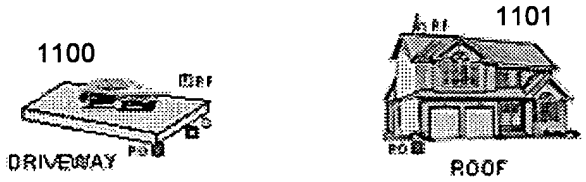
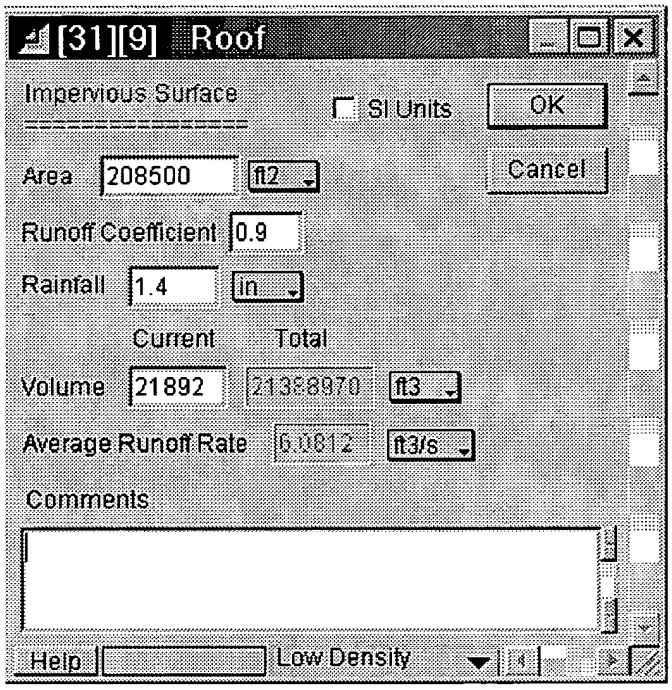

1000
[140][109] Evapotran...
Evapotranspiration
OK
Current Rate
0.1
mm
Cancel
1001
Comments
Help

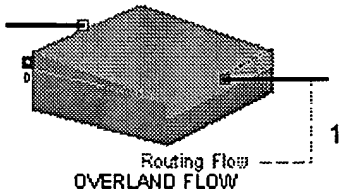
FIG. 10

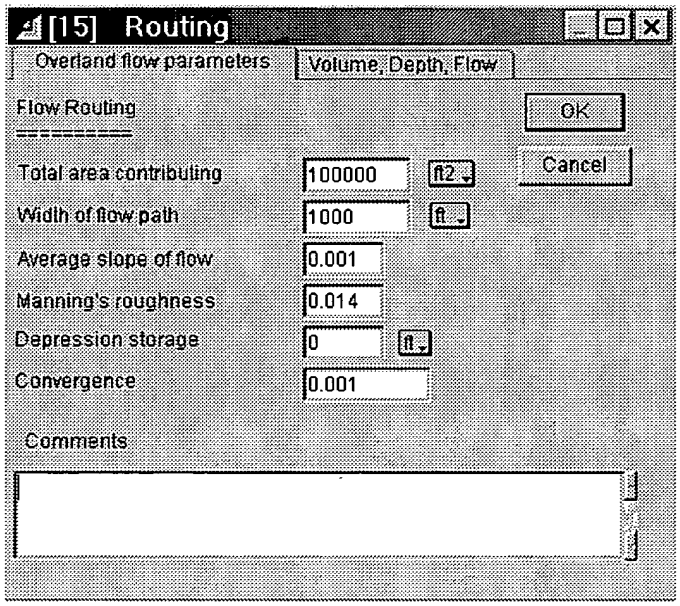

1100
1101
DRIVEWAY
ROOF


[31][9] Roof
Impervious Surface
SI Units
OK
Area 208500 ft2
Cancel
Runoff Coefficient 0.9
Rainfall 1.4 in
Current Total
Volume 21892 21388970 ft3
Average Runoff Rate 6.0812 ft3/s
Comments
Help
Low Density

1102

FIG. 11


1200
Routing Flow
OVERLAND FLOW


[15] Routing
Overland flow parameters
Volume, Depth, Flow
Flow Routing
OK
Cancel
Total area contributing
100000
ft2
Width of flow path
1000
ft
Average slope of flow
0.001
Manning's roughness
0.014
Depression storage
0
ft
Convergence
0.001
Comments
1201

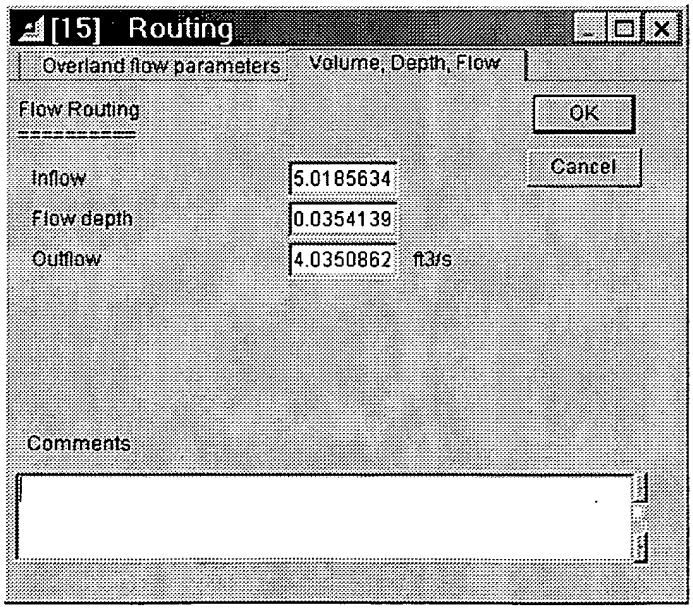
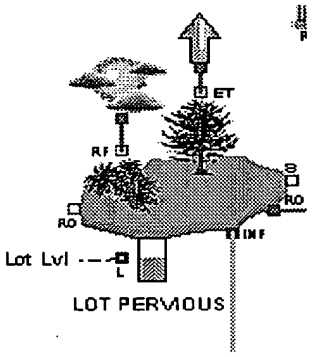
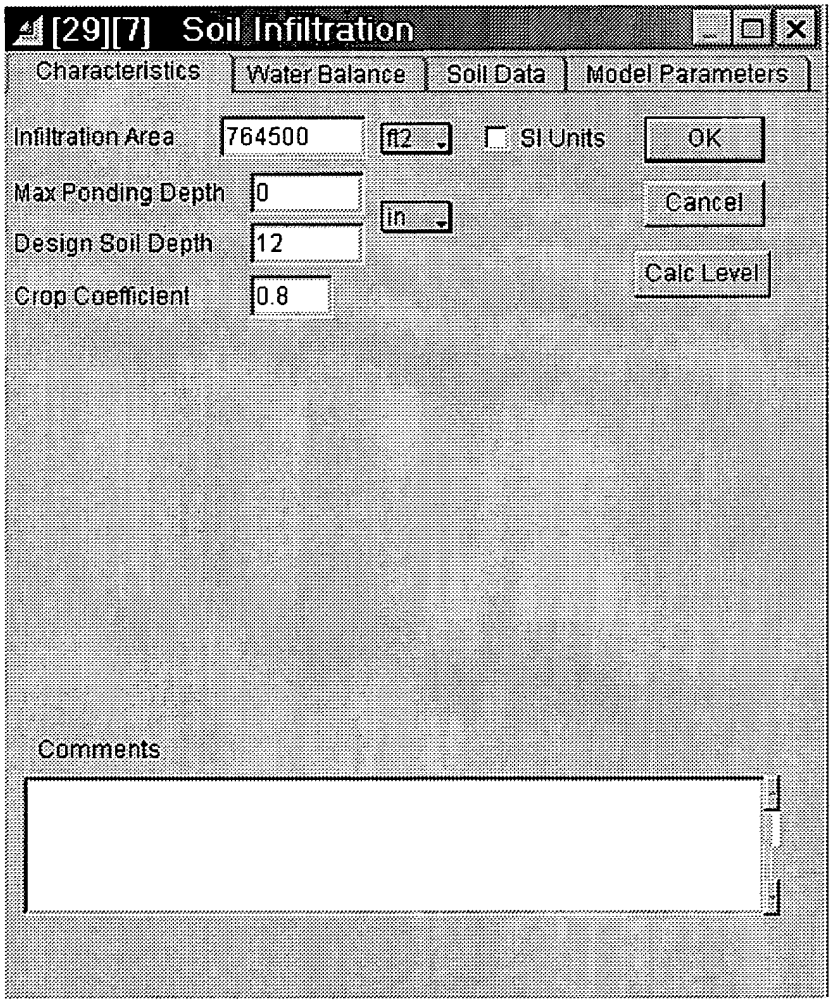

[15] Routing
Overland flow parameters
Volume, Depth, Flow
Flow Routing
OK
Cancel
Inflow
5.0185634
Flow depth
0.0354139
Outflow
4.0350862
ft3/s
Comments
1202

FIG. 12

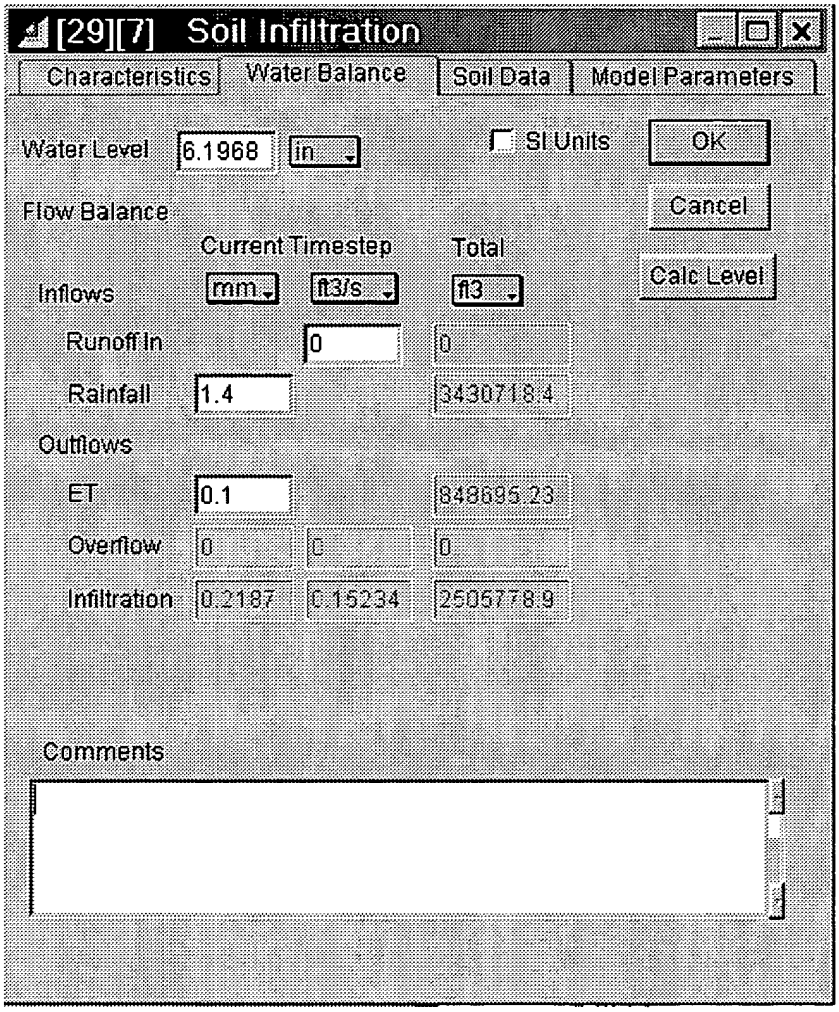


1300



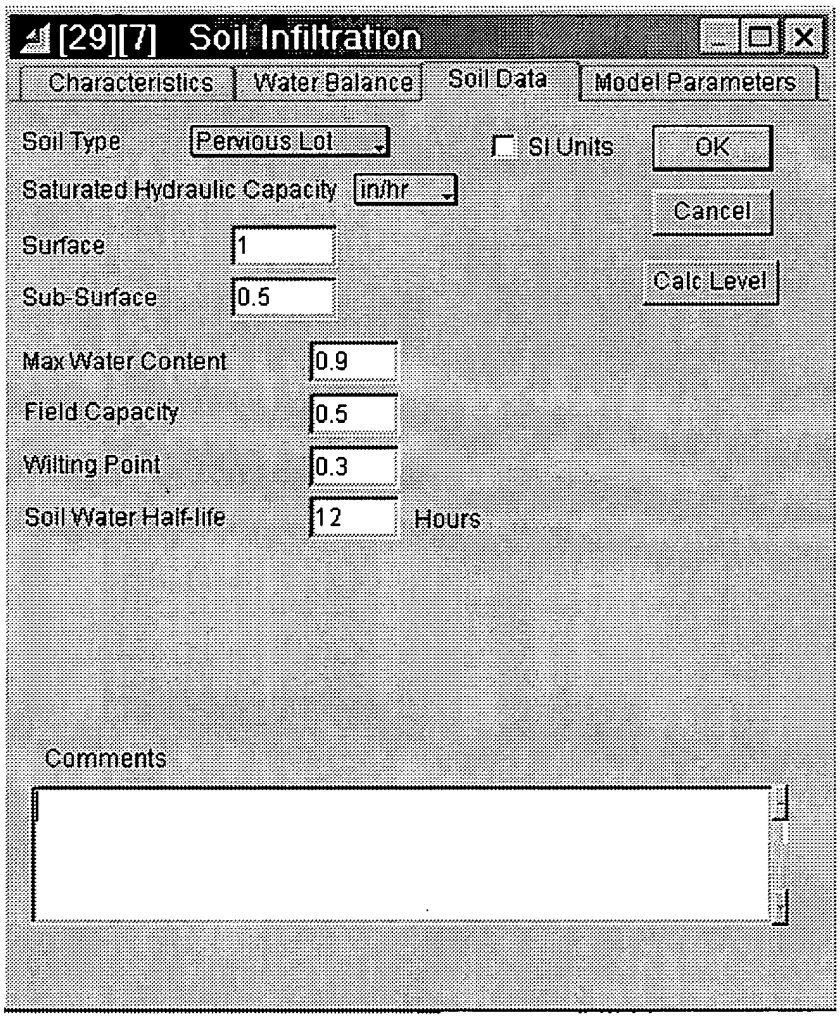
1301

FIG. 13A


[29][7] Soil Infiltration
Characteristics
Water Balance
Soil Data
Model Parameters
Water Level
6.1968
in
SI Units
OK
Cancel
Calc Level
Flow Balance
Current Timestep
Total
Inflows
mm
ft3/s
ft3
Runoff In
0
0
Rainfall
1.4
3430718.4
Outflows
ET
0.1
848695.23
Overflow
0
0
0
Infiltration
0.2187
0.15234
2506778.9
Comments

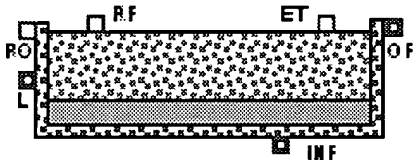
1302

FIG. 13B

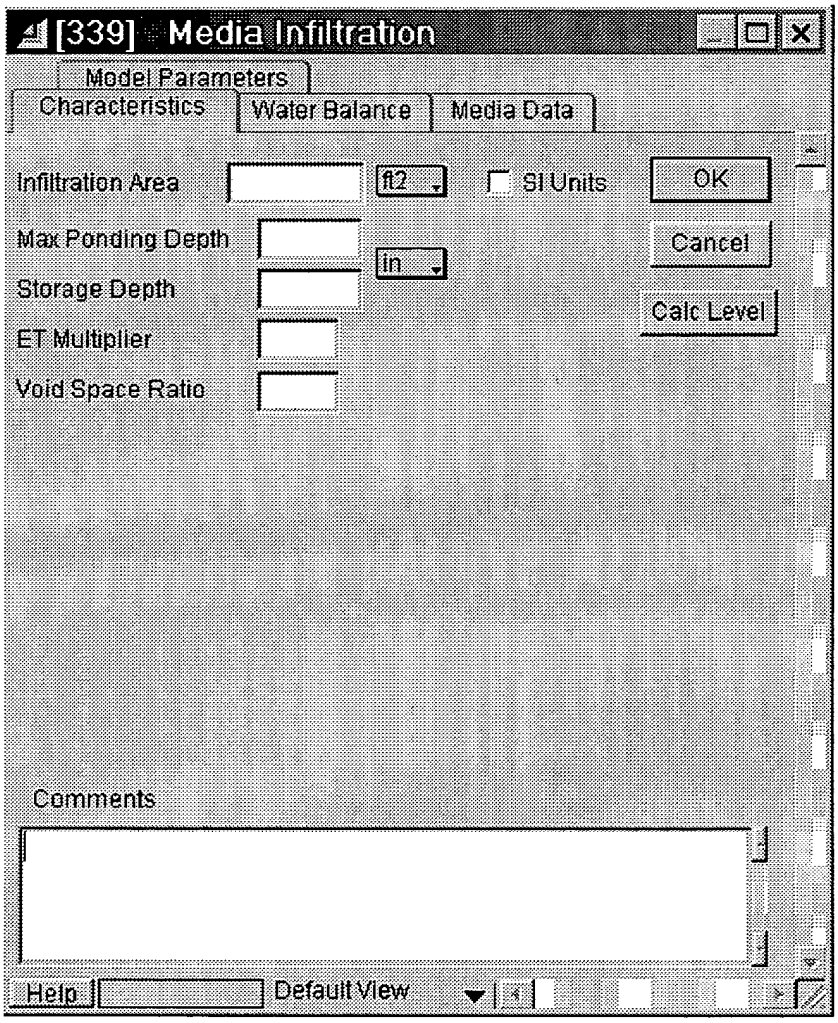

[29][7] Soil Infiltration
Characteristics
Water Balance
Soil Data
Model Parameters
Soil Type
Pervious Lot
SI Units
OK
Saturated Hydraulic Capacity
in/hr
Cancel
Surface
1
Sub-Surface
0.5
Calc Level
Max Water Content
0.9
Field Capacity
0.5
Wilting Point
0.3
Soil Water Half-life
12
Hours
Comments

1303

FIG. 13C

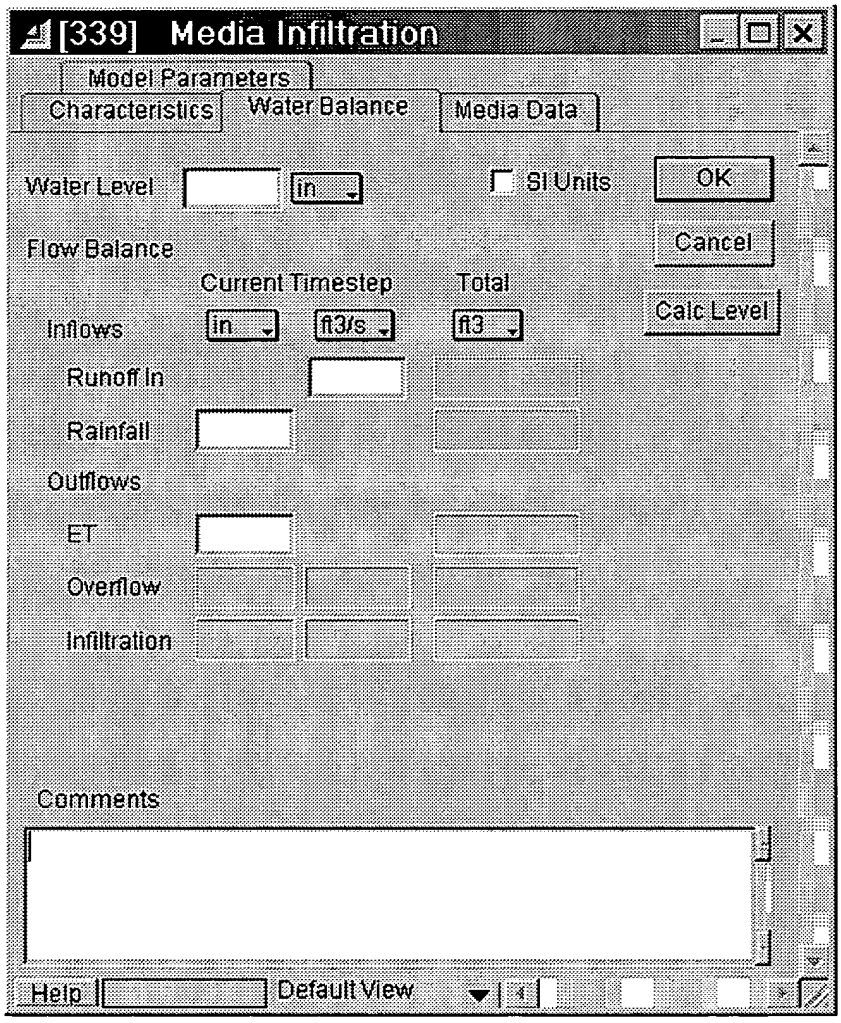


1400



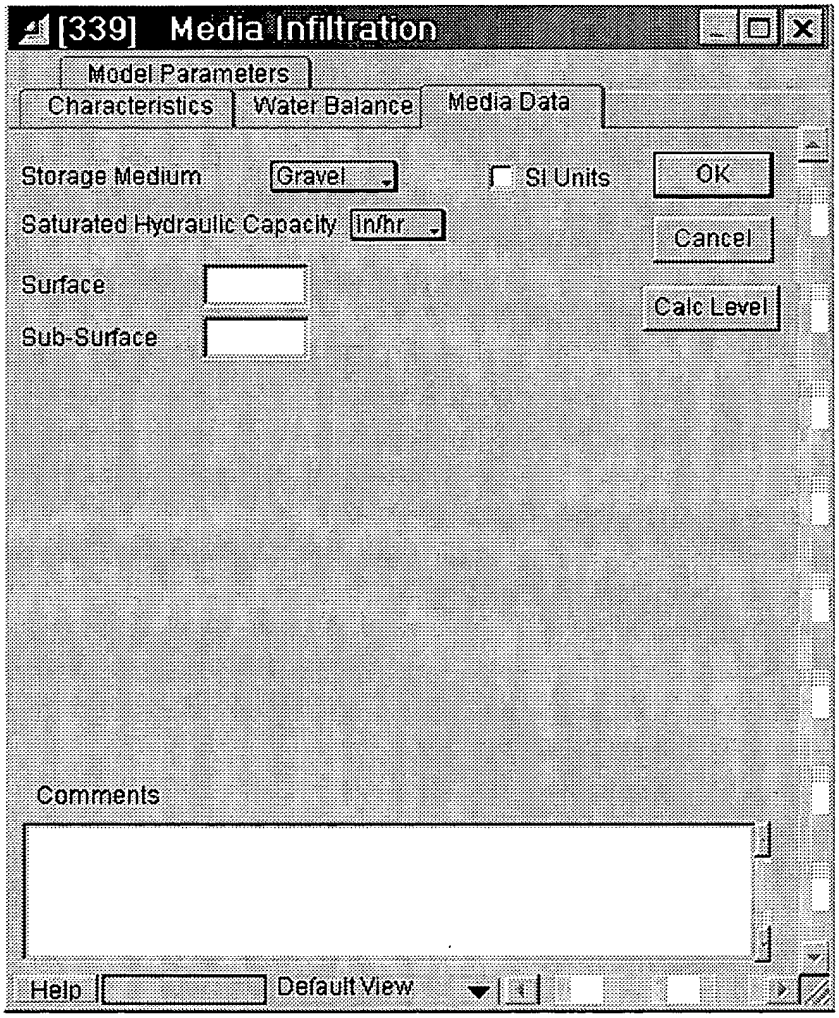
1401

FIG. 14A


[339] Media Infiltration
Model Parameters
Characteristics
Water Balance
Media Data
Water Level
in
SI Units
OK
Cancel
Flow Balance
Current Timestep
Total
Calc Level
Inflows
in
ft3/s
ft3
Runoff In
Rainfall
Outflows
ET
Overflow
Infiltration
Comments
Help
Default View

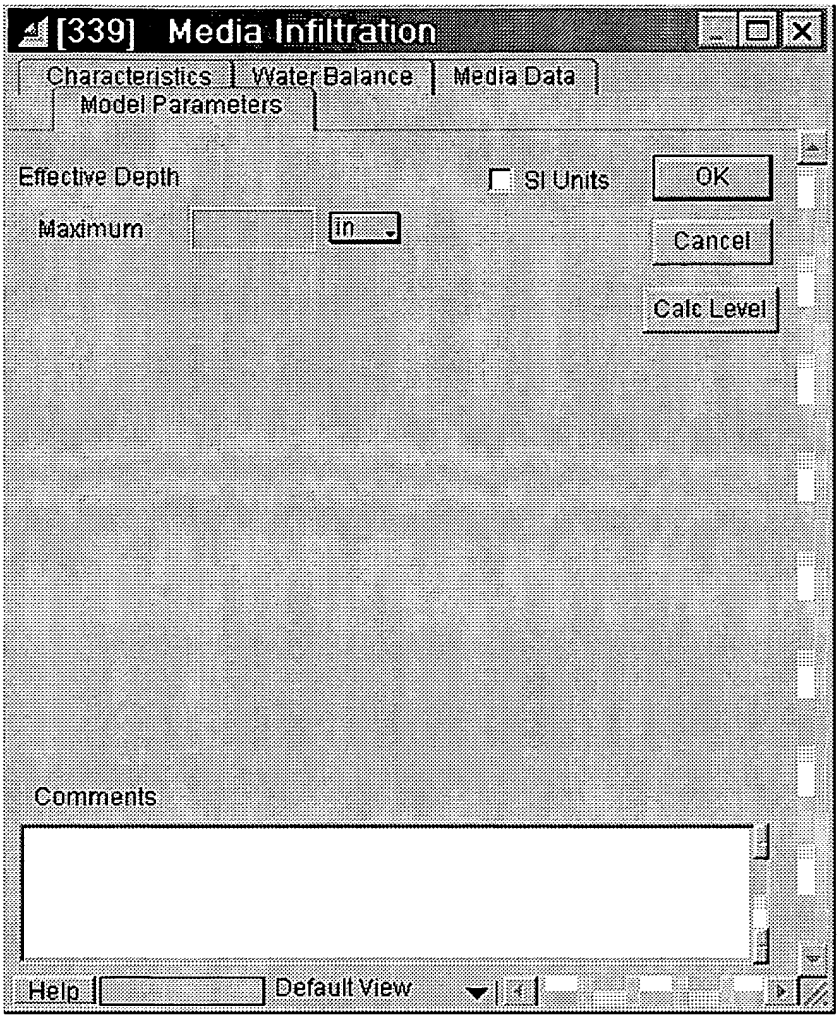
1402

FIG. 14B


[339] Media Infiltration
Model Parameters
Characteristics
Water Balance
Media Data
Storage Medium
Gravel
SI Units
OK
Saturated Hydraulic Capacity
in/hr
Cancel
Surface
Calc Level
Sub-Surface
Comments
Help
Default View

1403

FIG. 14C


[339] Media Infiltration
Characteristics
Water Balance
Media Data
Model Parameters
Effective Depth
SI Units
OK
Maximum
in
Cancel
Calc Level
Comments
Help
Default View

1404

FIG. 14D

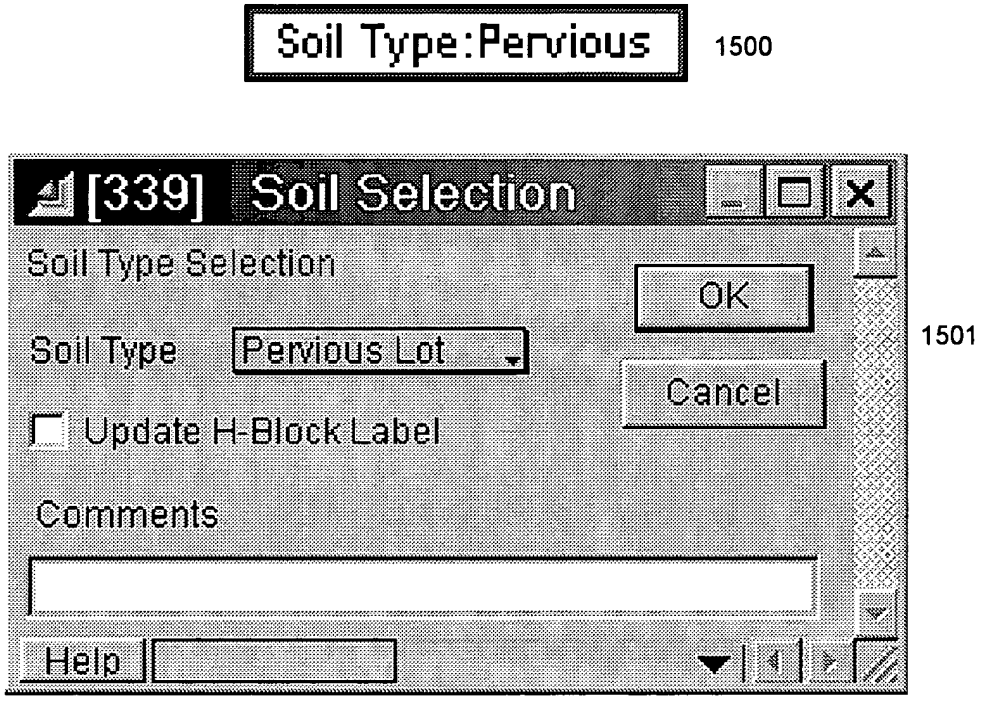

Soil Type:Pervious
1500
[339] Soil Selection
Soil Type Selection
OK
Soil Type
Pervious Lot
Cancel
Update H-Block Label
Comments
Help
1501

FIG. 15

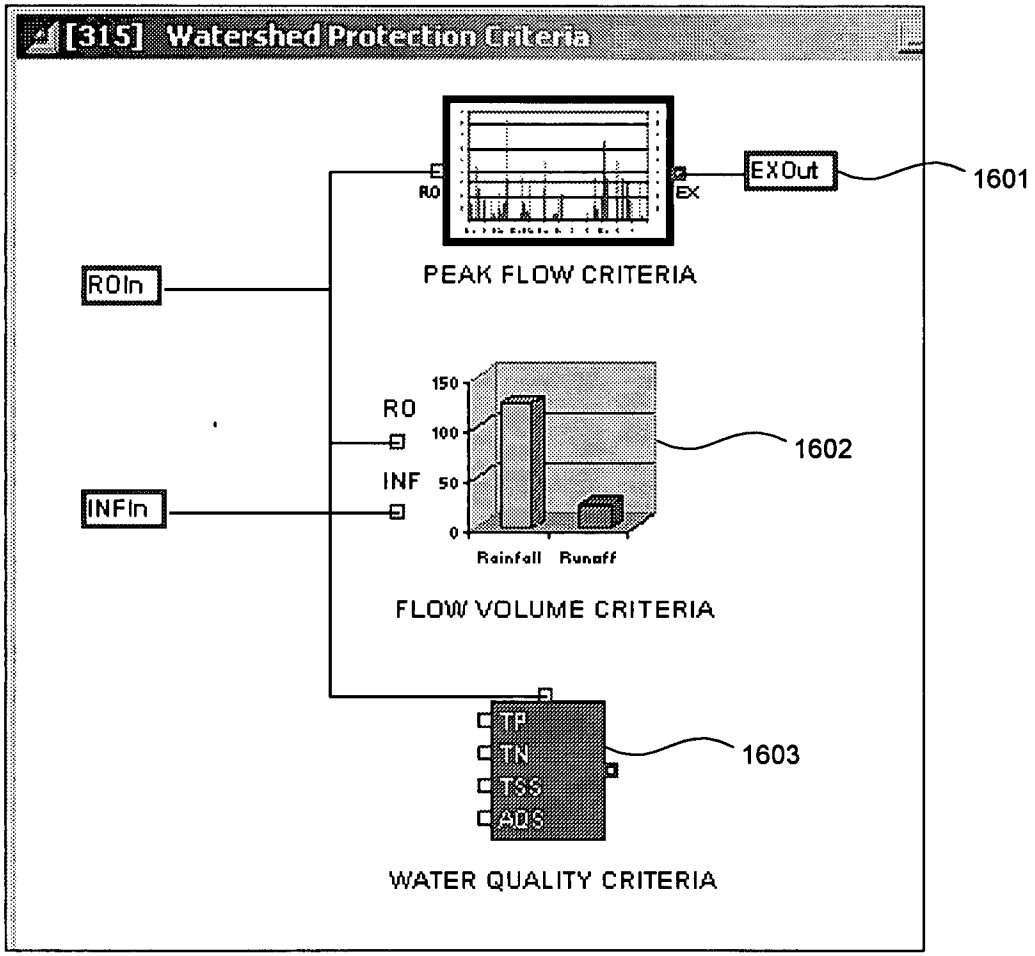
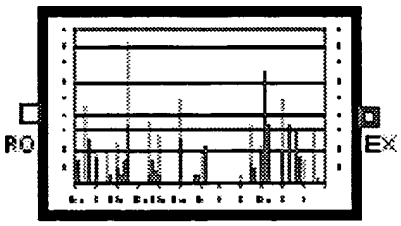
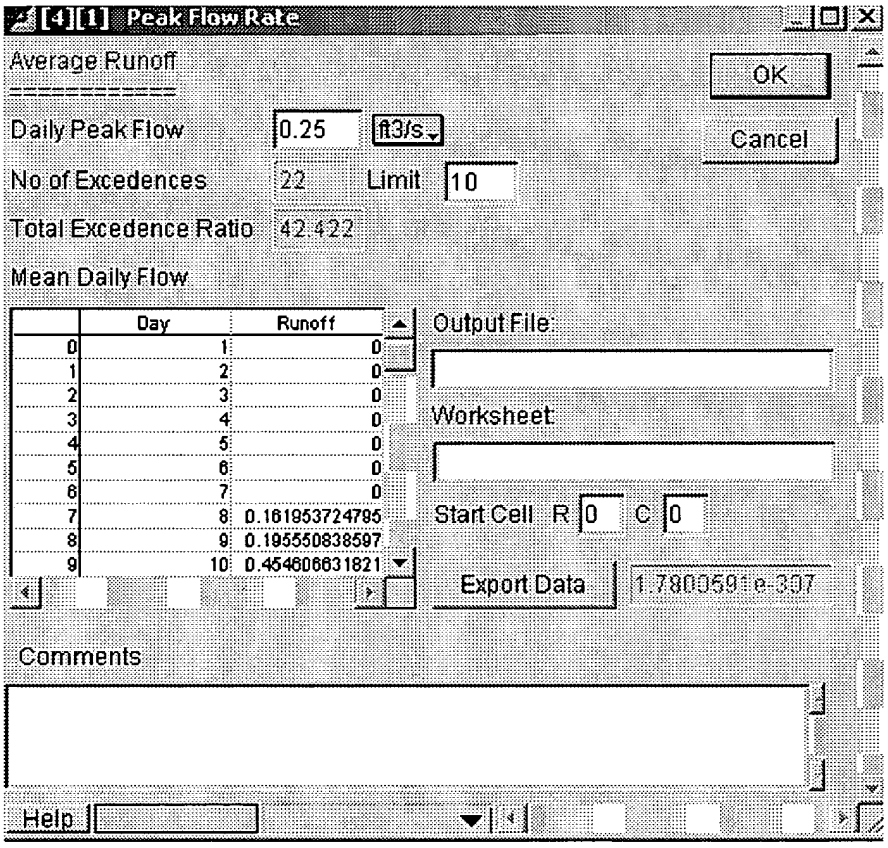

[315] Watershed Protection Criteria
RO
EX
EXOut
1601
PEAK FLOW CRITERIA
ROIn
150
100
50
0
RO
INF
INFIn
1602
Rainfall
Runoff
FLOW VOLUME CRITERIA
TP
TN
TSS
ADS
1603
WATER QUALITY CRITERIA

FIG. 16



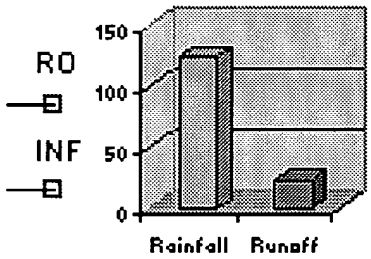
1700

PEAK FLOW CRITERIA



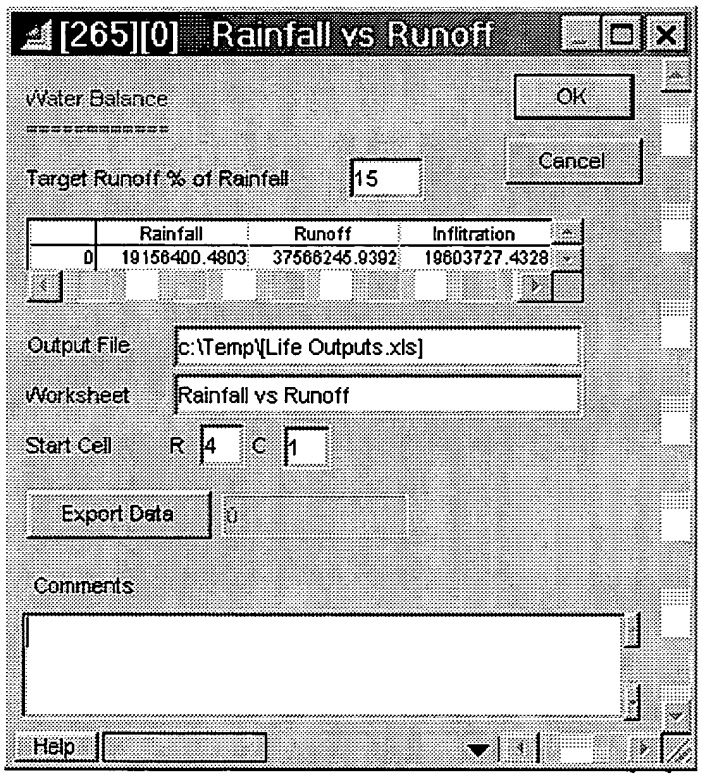
1701

FIG. 17



1800

FLOW VOLUME CRITERIA



1801

FIG. 18

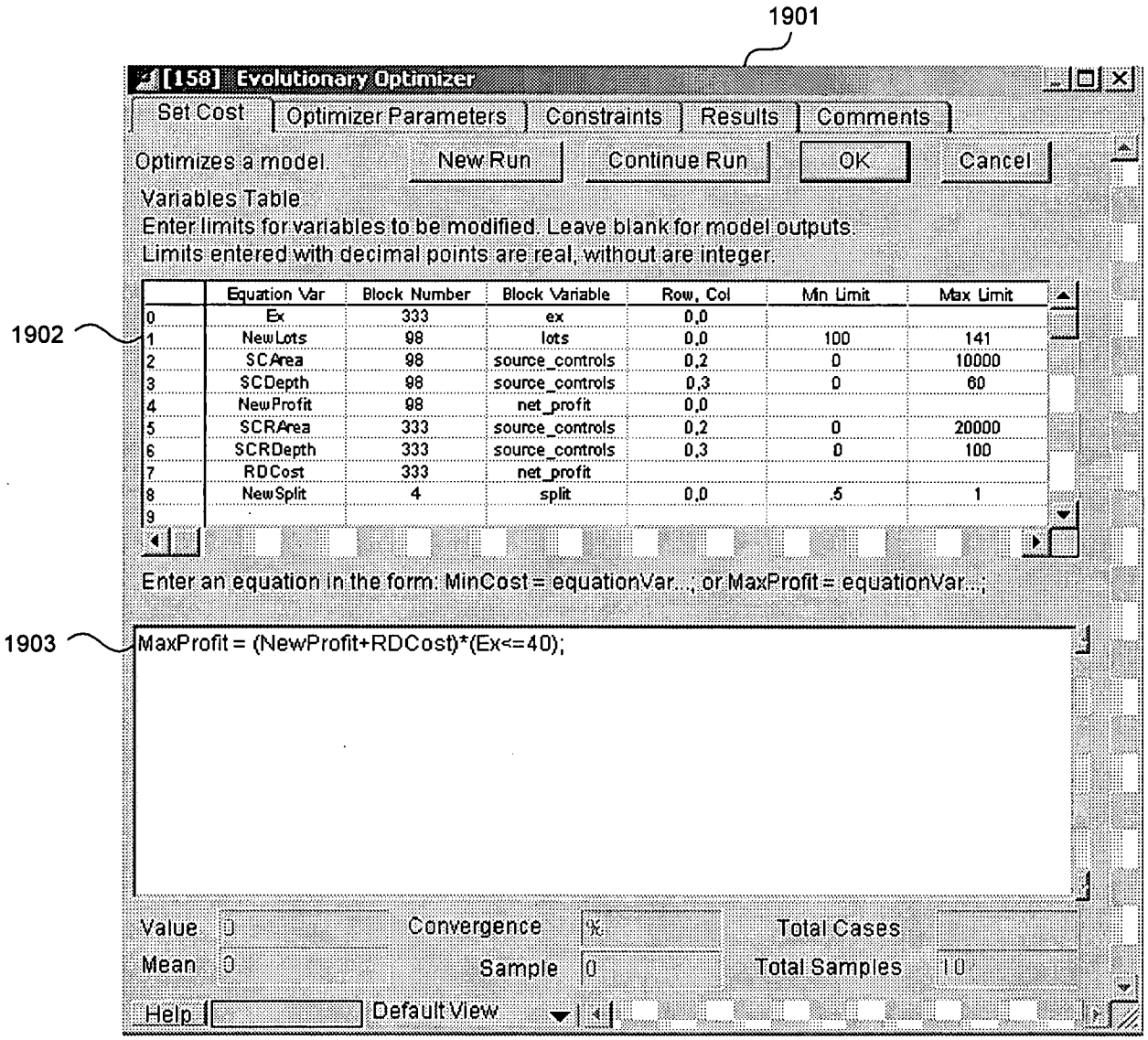

1901
[158] Evolutionary Optimizer
Set Cost
Optimizer Parameters
Constraints
Results
Comments
Optimizes a model.
New Run
Continue Run
OK
Cancel
Variables Table
Enter limits for variables to be modified. Leave blank for model outputs.
Limits entered with decimal points are real, without are integer.
1902
Equation Var | Block Number | Block Variable | Row, Col | Min Limit | Max Limit
0 | Ex | 333 | ex | 0,0 | | |
1 | NewLots | 98 | lots | 0,0 | 100 | 141
2 | SCArea | 98 | source_controls | 0,2 | 0 | 10000
3 | SCDepth | 98 | source_controls | 0,3 | 0 | 60
4 | NewProfit | 98 | net_profit | 0,0 | | |
5 | SCRArea | 333 | source_controls | 0,2 | 0 | 20000
6 | SCRDepth | 333 | source_controls | 0,3 | 0 | 100
7 | RDCost | 333 | net_profit | | | |
8 | NewSplit | 4 | split | 0,0 | .5 | 1
9
Enter an equation in the form: MinCost = equationVar...; or MaxProfit = equationVar...;
1903
MaxProfit = (NewProfit+RDCost)*(Ex<=40);
Value
Convergence
%
Total Cases
Mean
Sample
Total Samples
Help
Default View

FIG. 19A

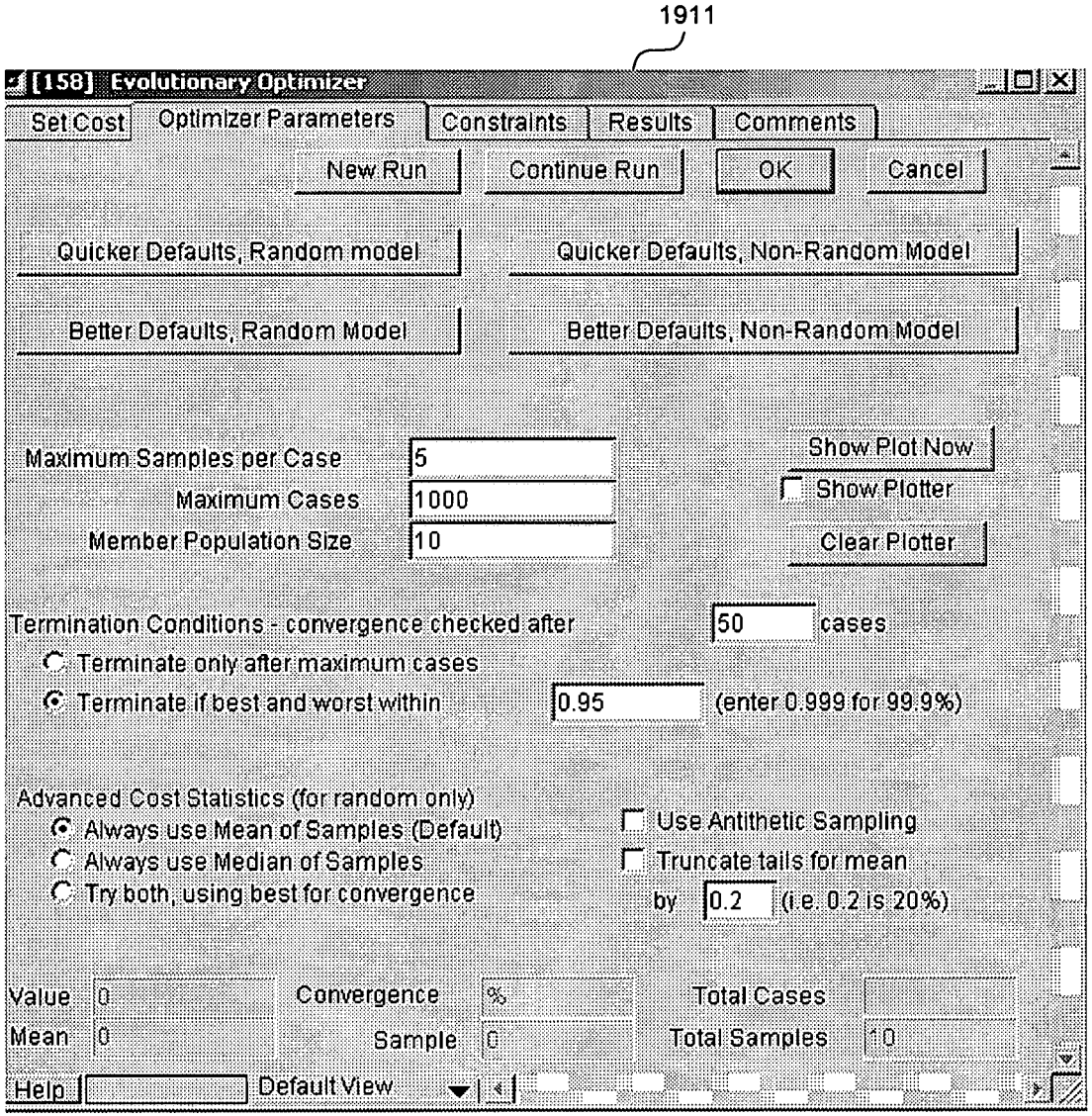

1911
[158] Evolutionary Optimizer
Set Cost
Optimizer Parameters
Constraints
Results
Comments
New Run
Continue Run
OK
Cancel
Quicker Defaults, Random model
Quicker Defaults, Non-Random Model
Better Defaults, Random Model
Better Defaults, Non-Random Model
Maximum Samples per Case
5
Maximum Cases
1000
Member Population Size
10
Show Plot Now
Show Plotter
Clear Plotter
Termination Conditions - convergence checked after
50
cases
Terminate only after maximum cases
Terminate if best and worst within
0.95
(enter 0.999 for 99.9%)
Advanced Cost Statistics (for random only)
Always use Mean of Samples (Default)
Always use Median of Samples
Try both, using best for convergence
Use Antithetic Sampling
Truncate tails for mean
by
0.2
(i.e. 0.2 is 20%)
Value
0
Mean
0
Convergence
%
Sample
0
Total Cases
Total Samples
10
Help
Default View

FIG. 19B

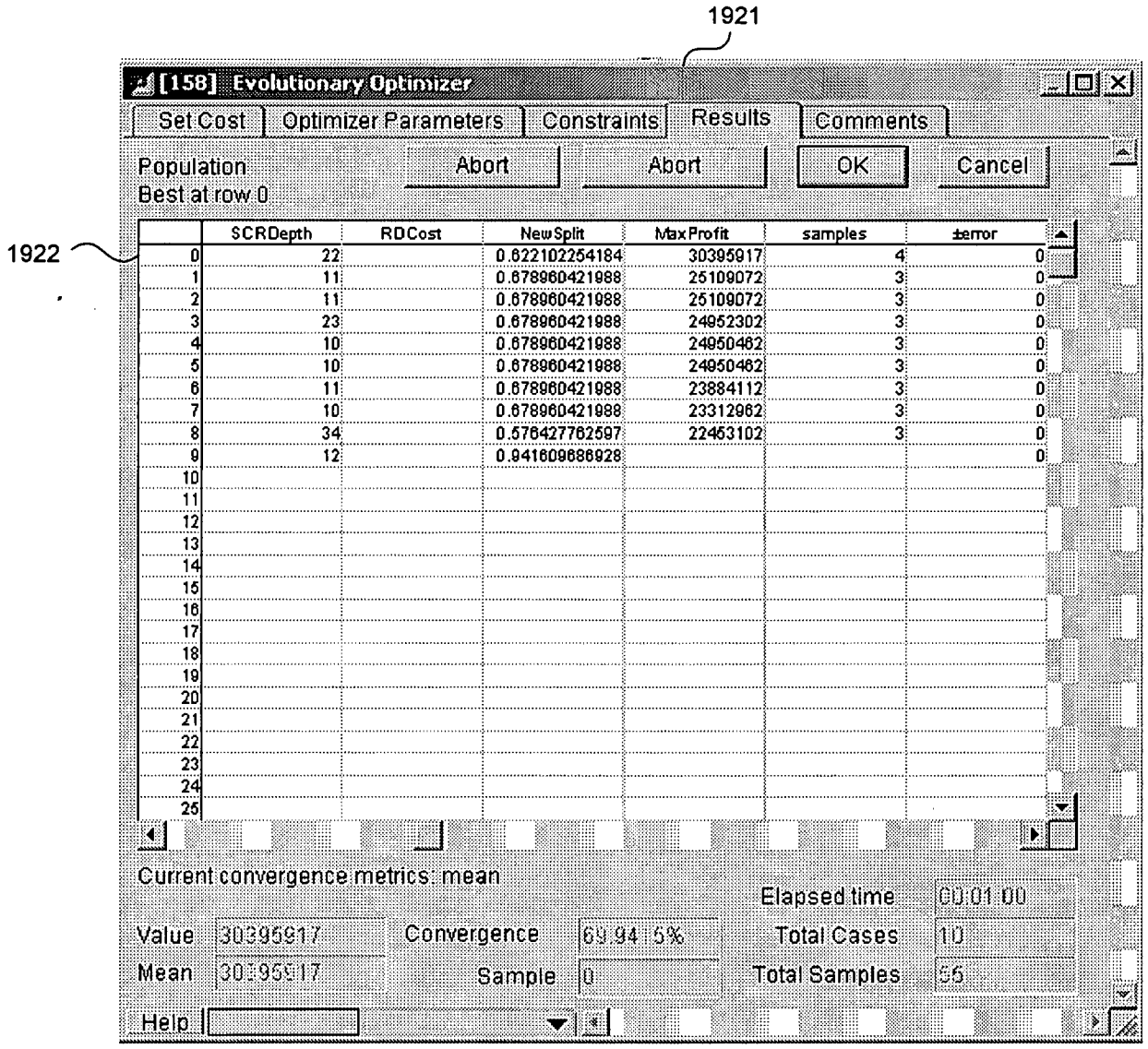

1921
[158] Evolutionary Optimizer
Set Cost
Optimizer Parameters
Constraints
Results
Comments
Population
Best at row 0
Abort
Abort
OK
Cancel
1922
SCRDepth
RDCost
NewSplit
MaxProfit
samples
±error
0 22 0.622102254184 30395917 4 0
1 11 0.678960421988 25109072 3 0
2 11 0.678960421988 25109072 3 0
3 23 0.678960421988 24952302 3 0
4 10 0.678960421988 24950462 3 0
5 10 0.678960421988 24950462 3 0
6 11 0.678960421988 23884112 3 0
7 10 0.678960421988 23312962 3 0
8 34 0.576427762597 22463102 3 0
9 12 0.941609686928 0
Current convergence metrics: mean
Elapsed time 00:01:00
Value 30395917
Convergence 69.94 5%
Total Cases 10
Mean 30395917
Sample 0
Total Samples 56
Help

FIG. 19C

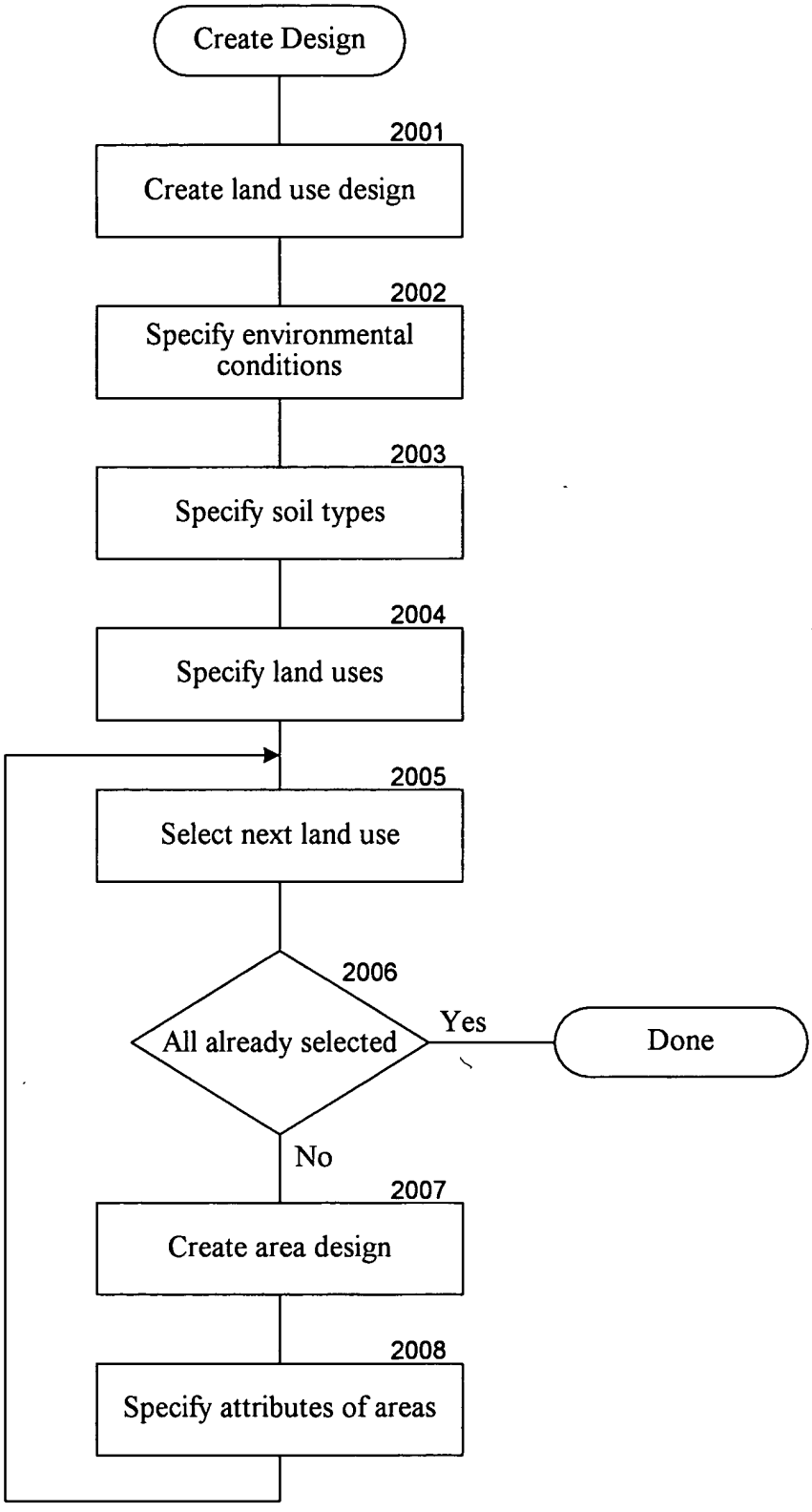

Create Design
2001
Create land use design
2002
Specify environmental conditions
2003
Specify soil types
2004
Specify land uses
2005
Select next land use
2006
All already selected
Yes
Done
No
2007
Create area design
2008
Specify attributes of areas

FIG. 20

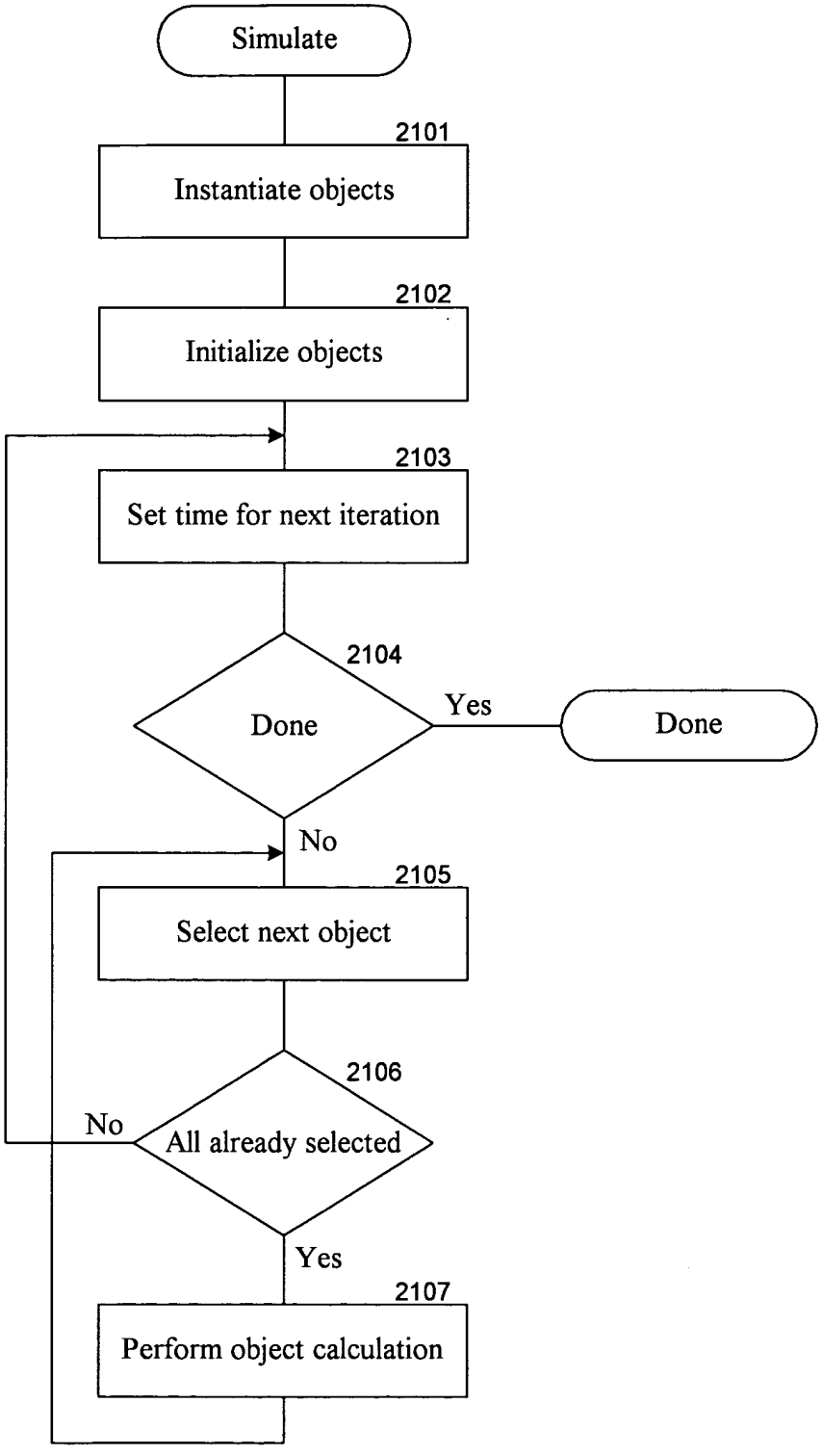

Simulate
2101
Instantiate objects
2102
Initialize objects
2103
Set time for next iteration
2104
Done
Yes
Done
No
2105
Select next object
2106
No
All already selected
Yes
2107
Perform object calculation

FIG. 21

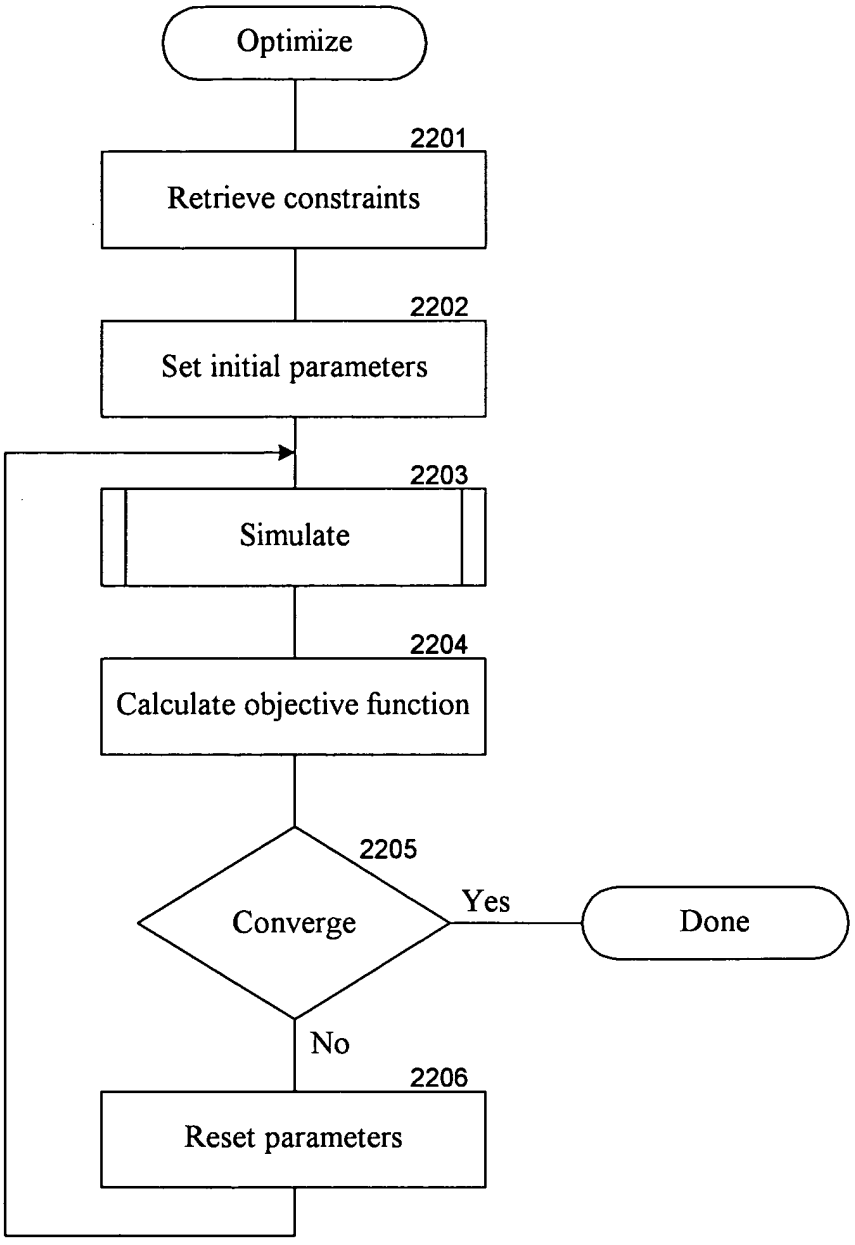

Optimize
2201
Retrieve constraints
2202
Set initial parameters
2203
Simulate
2204
Calculate objective function
2205
Converge
Yes
Done
No
2206
Reset parameters

FIG. 22

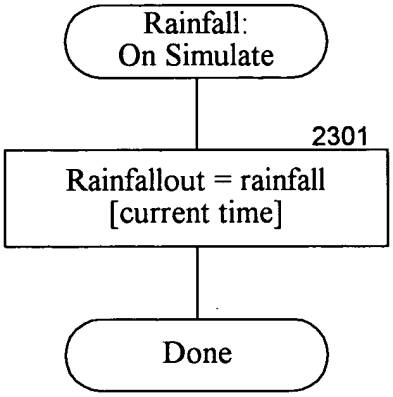

Rainfall:
On Simulate
2301
Rainfallout = rainfall
[current time]
Done

FIG. 23

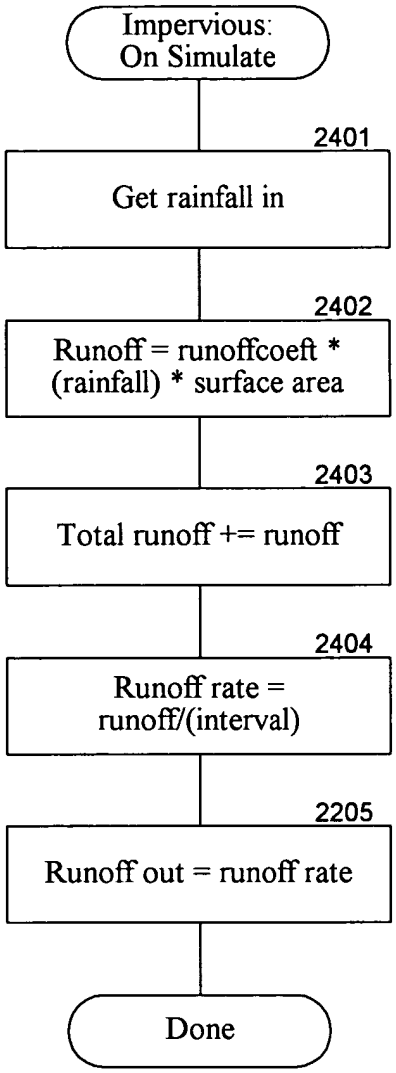

Impervious:
On Simulate
2401
Get rainfall in
2402
Runoff = runoffcoeft *
(rainfall) * surface area
2403
Total runoff += runoff
2404
Runoff rate =
runoff/(interval)
2205
Runoff out = runoff rate
Done

FIG. 24

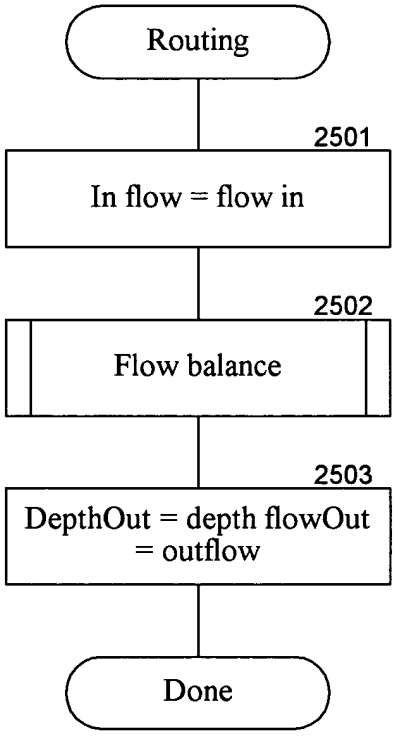

Routing
2501
In flow = flow in
2502
Flow balance
2503
DepthOut = depth flowOut = outflow
Done

FIG. 25

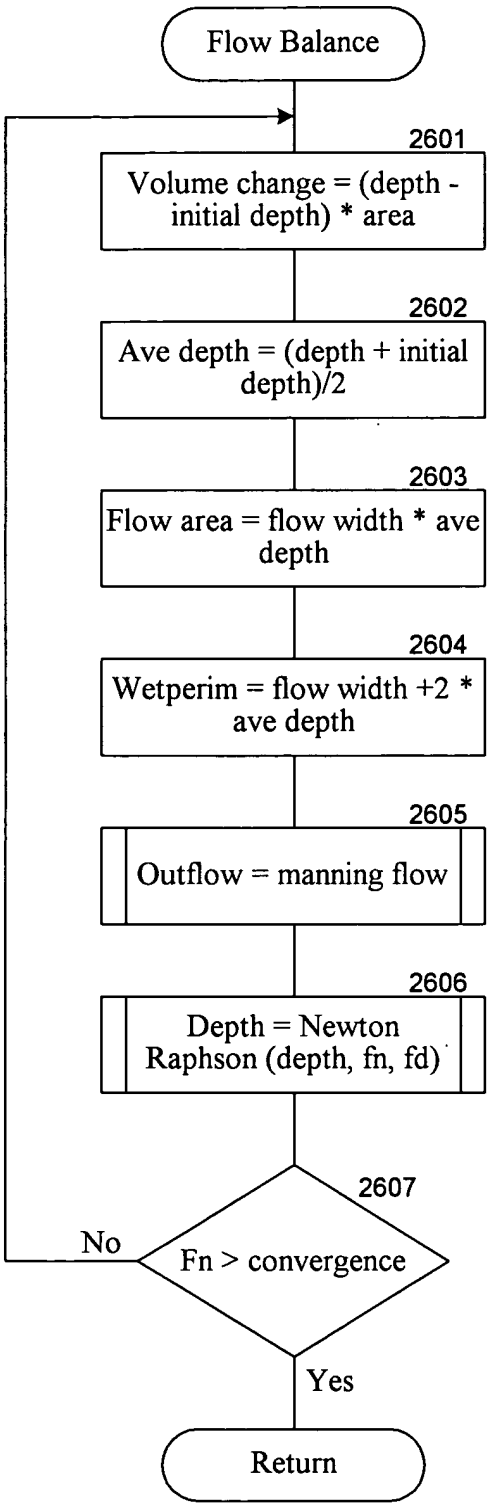

Flow Balance
2601
Volume change = (depth - initial depth) * area
2602
Ave depth = (depth + initial depth)/2
2603
Flow area = flow width * ave depth
2604
Wetperim = flow width +2 * ave depth
2605
Outflow = manning flow
2606
Depth = Newton Raphson (depth, fn, fd)
2607
Fn > convergence
No
Yes
Return

FIG. 26

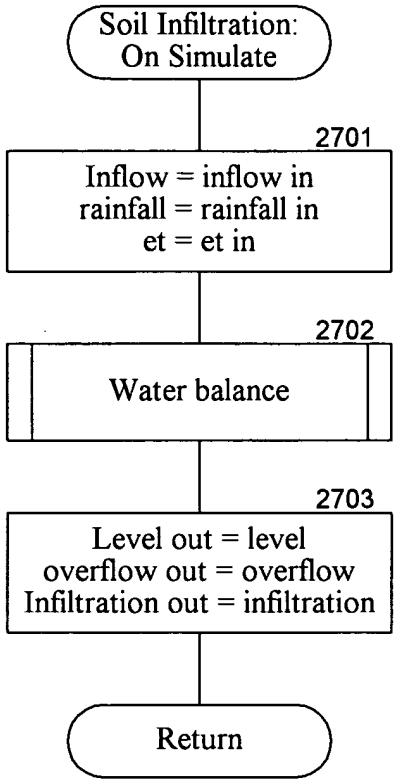

Soil Infiltration:
On Simulate
2701
Inflow = inflow in
rainfall = rainfall in
et = et in
2702
Water balance
2703
Level out = level
overflow out = overflow
Infiltration out = infiltration
Return

FIG. 27

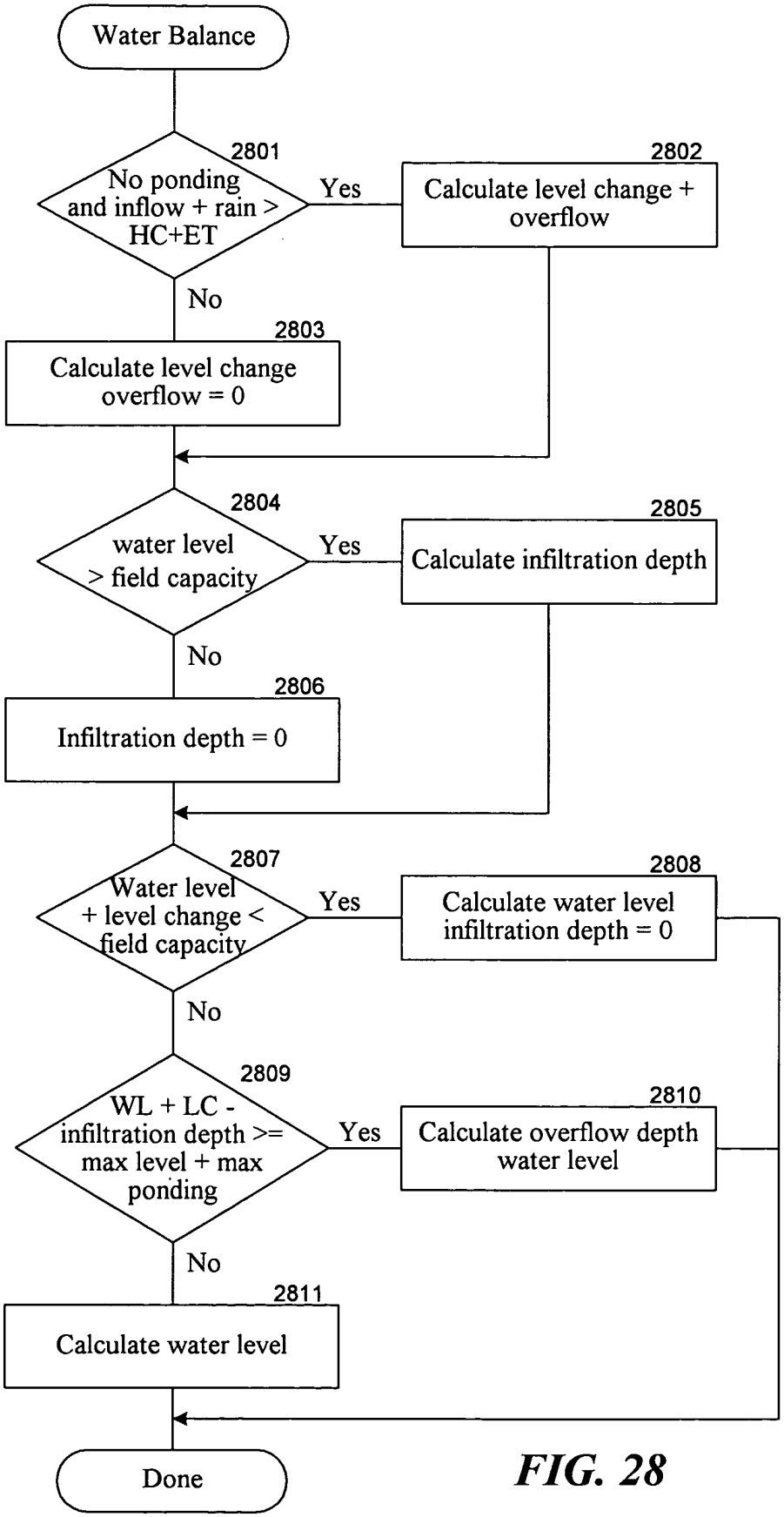

Water Balance
2801
No ponding and inflow + rain > HC+ET
Yes
2802
Calculate level change + overflow
No
2803
Calculate level change overflow = 0
2804
water level > field capacity
Yes
2805
Calculate infiltration depth
No
2806
Infiltration depth = 0
2807
Water level + level change < field capacity
Yes
2808
Calculate water level infiltration depth = 0
No
2809
WL + LC - infiltration depth >= max level + max ponding
Yes
2810
Calculate overflow depth water level
No
2811
Calculate water level
Done

FIG. 28